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# Size, Volume, and Weight of Pine Slabs and Edgings in the South Carolina Piedmont

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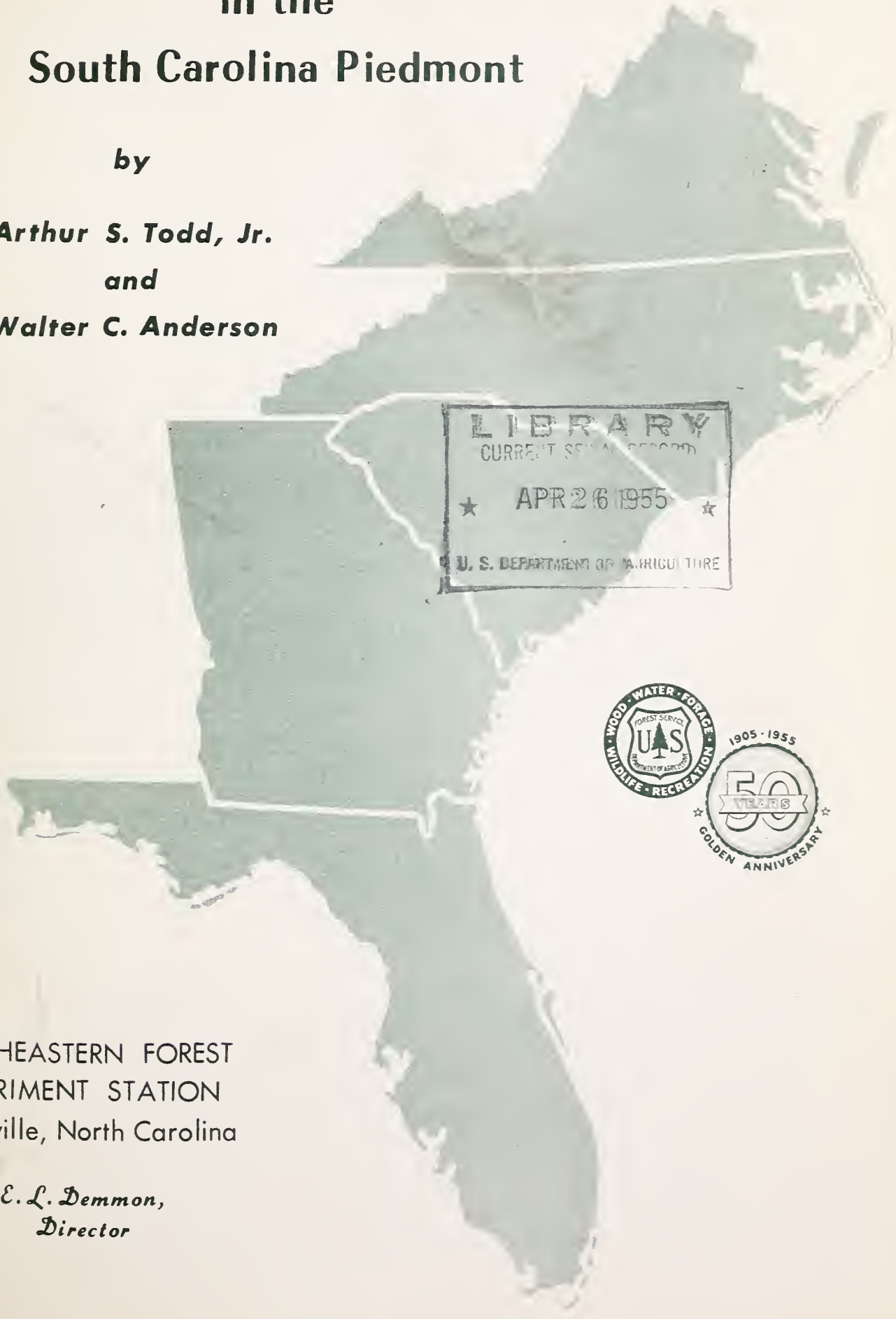
*by*

***Arthur S. Todd, Jr.***
***and***
***Walter C. Anderson***



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# SIZE, VOLUME, AND WEIGHT OF PINE SLABS AND EDGINGS IN THE SOUTH CAROLINA PIEDMONT

by

A. S. Todd, Jr., and Walter C. Anderson

## INTRODUCTION

Paper and board products from slabs and other solid sawmill residues are now a reality in the Southeast. Debarking and chipping machinery are being installed at the larger lumber plants, and pulp companies have contracted to buy the resulting chips.

Aside from the mechanical difficulties to be expected with new lines of production, there appear to be no serious obstacles to the conversion of waste wood to bark-free chips at sawmills big enough to warrant installation of log debarkers. However, 90 percent or more of the potentially chippable residues are at sawmills that produce less than 16,000 board feet of lumber a day, hardly enough for profitable operation of any log debarker now on the market. As an added complication, many of the smaller sawmills are portables that would be handicapped by the weight of the extra equipment.

If a substantial volume of residues is to be utilized for pulp, specialized methods of procuring, transporting, and processing small-mill slabs and edging strips must be developed. For maximum efficiency, these methods must be designed with the physical characteristics of the material to be handled clearly in mind. The same information is also essential in deciding what proportion of the residues can be profitably utilized, how they should be measured for sale or purchase, and how much they are worth as a source of raw wood.

To provide some of the needed information, this Station Paper reports on the sizes of pine slabs and edgings produced at small sawmills in the central Piedmont and on the volumes and weights of wood and bark components. It is the second report from a continuing investigation of the problems of salvaging and marketing small-mill residues in this region.

## THE SAMPLES

To obtain information on the size and volume characteristics of southern pine slabs and edgings, four small sawmills were selected at random from all those within a 2,800-square-mile area in the South Carolina Piedmont. This area and its sawmills were completely described and the output of chippable residues reported in the first report of this investigation.[1/]

At each of the four mills a sample of 10 logs was so selected as to include the range of diameters being sawed (table 1). These logs were predominantly shortleaf pine with a small admixture of loblolly. The output included both 1-inch boards and structural dimension. All of it was square-edged but none was end-trimmed.

Table 1.--Distribution of sample logs by diameter and length[1/]

(In numbers)

| Scaling diameter (Inches) | Length | | | | | | |
|---|---|---|---|---|---|---|---|
| | 8 ft. | 10 ft. | 12 ft. | 14 ft. | 16 ft. | 18 ft. | All lengths |
| 5 | -- | -- | -- | 1 | -- | -- | 1 |
| 6 | 2 | 1 | 1 | 1 | -- | -- | 5 |
| 7 | 2 | -- | 1 | 1 | 1 | -- | 5 |
| 8 | -- | -- | 5 | 3 | -- | -- | 8 |
| 9 | -- | -- | 1 | 1 | 1 | 1 | 4 |
| 10 | -- | -- | 4 | 1 | -- | -- | 5 |
| 11 | -- | -- | 2 | -- | -- | -- | 2 |
| 12 | -- | -- | 1 | 1 | -- | -- | 2 |
| 13 | -- | -- | 1 | 2 | -- | -- | 3 |
| 14 | -- | -- | 1 | -- | -- | -- | 1 |
| 15 | -- | -- | 2 | -- | -- | -- | 2 |
| 16 | -- | -- | -- | -- | -- | -- | -- |
| 17 | -- | -- | -- | -- | -- | -- | -- |
| 18 | -- | -- | -- | -- | -- | -- | -- |
| 19 | -- | -- | 2 | -- | -- | -- | 2 |
| All diameters | 4 | 1 | 21 | 11 | 2 | 1 | 40 |

1/ Miscut logs are classed under the next lower 2-foot length.

The smallest size of lumber produced was a 1 x 4-8 feet long. The sizes and volumes of residues from logs of other species or from logs sawed to other standards may, of course, be quite different from those reported here.

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1/ Todd, A. S., Jr. Sawmill and logging residues in the South Carolina Piedmont: problems and methods of salvage. Southeastern Forest Experiment Station Paper No. 31, Nov. 1953.

The residues from the 40 sample logs consisted of 153 slabs and 281 edgings. All the slabs and 220 of the edgings were measured by 2-foot sections for cubic-foot volume inside and outside bark. Widths and thicknesses of slabs were taken to the nearest 1/10-inch at each measuring point (fig. 1), and the cross-sections were computed as areas of circular segments. For the edgings, the measurements taken were the widths of both faces and the thickness, also to the nearest 1/10-inch. The average of the two widths was then multiplied by the thickness to obtain the cross-sectional area. This formula gives edging volumes that are very slightly on the conservative side, since it ignores the curvature of the bark face.

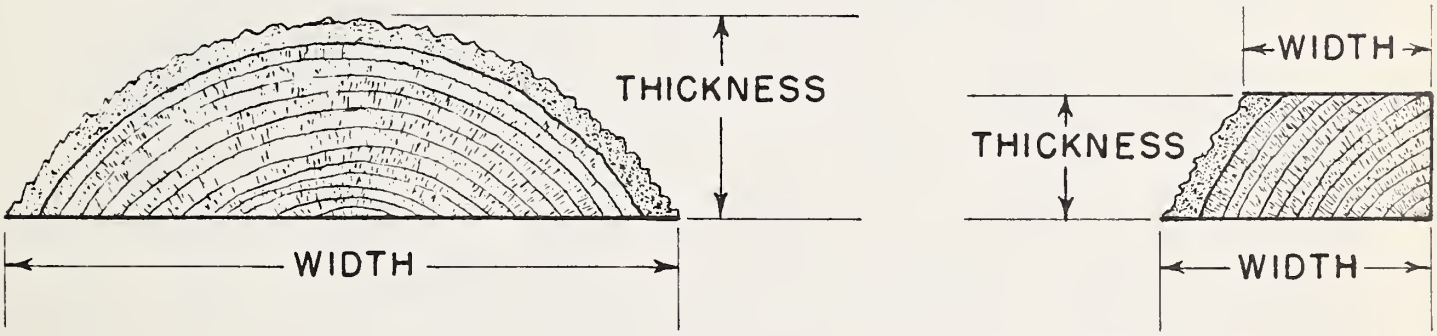


Figure 1.--Cross-sectional measurements taken at each 2-foot point on sample slabs and edgings.

The weight sample consisted of 100 sections of edging strips, 20 from each of five sawmills. Every section was from a different log. These pieces were the thickness of the strips (1 to 1-1/2 inches), of varying widths up to 3 inches, and 10 inches long. After the 10-inch blocks were sawed out, a pocket knife was used to divide them into separate samples of wood and of bark.

While still fresh, the bark and wood samples were weighed to the nearest 1/10 gram and their volumes measured to the nearest cubic centimeter by immersion in a 1000 c.c. graduate. They were then oven-dried at 105 degrees Centigrade and reweighed.

It was early spring when the weight samples were collected. Bark growth for the year had already commenced, but wood growth apparently had not. Consequently, wood and bark could not be separated perfectly, some inner bark adhering to the wood. Similar

difficulties are experienced at that time of year with debarking machines. In the present case, the adhering bark affected the unit wood weights little if at all, but the bark weights are probably somewhat different from those that would have been obtained later in the spring or in other seasons of the year.

## SLABS VERSUS EDGINGS

Slabs and edgings are distinctly different in size and shape. Therefore, they present different problems of salvage, and methods highly suitable for one may not be applicable to the other. Indeed, some informed individuals feel that edgings contain too little wood per piece to justify transporting and debarking. For these reasons, the relative proportions of slabs and edgings are of interest.

Observation indicates that the proportions are rather variable, differing according to the kind of lumber produced, the size and form of the logs, and the practices of the mill owners or sawyers. Few edgers in the study area are operated at anything approaching capacity. Logs are customarily sawed "four-sides" on the headsaw, so that only the short or wany cuts produced in "squaring up" require edging. The sawmills sampled for residues were typical in this respect. At these mills, slabs comprised from 60 to 71 percent of total residue volume and averaged exactly two-thirds. However, the mill with the smallest proportion (60 percent) was sawing larger-than-average logs into 1-inch boards. The proportion of slabs at the other three mills, which were sawing both boards and 2-inch stock, ranged only from 66 to 71 percent.

Judging by the four sample mills, the effect of log size on slab output is marked but inconsistent from mill to mill. Other things being equal, the proportion of total residue in slabs is low for the smallest logs, rises to a maximum at a diameter of about 10 inches, and then declines.

## WOOD VERSUS BARK

Current interest in sawmill residues is restricted to the wood component. Bark is useful only for fuel, and its value for this purpose is too small to justify expenditures for transporting it. Furthermore, bark removal seems certain to be one of the more troublesome and costlier steps in preparing sawmill residues for pulping. For these reasons, it is important to know how much bark must be handled per unit volume or weight of wood.

The sample slabs ranged from practically zero volume to 1.130 cubic feet of wood and bark together, and averaged 0.469 cubic foot. The edgings ranged to 0.290 cubic foot and averaged 0.114. The bark on the slabs and edgings averaged 0.36 inch thick. The mean cubic-foot volumes of bark per piece were as follows:

| | |
|---|---|
| Per slab | .153 |
| Per edging | .029 |

In terms of total solid volume, the slabs averaged 33 percent bark, the edgings 25 percent. The average weights per cubic foot of the bark and wood in the sample slabs and edgings were found to be 34.7 and 63.3 pounds, respectively (table 2). Therefore, in terms of total green weight, the slabs averaged 21 percent bark, the edgings 16 percent.

Table 2.--Average unit weights of bark and wood in slabs and edgings

(In pounds per cubic foot)

| Material | Green1/ | Oven-dry |
|---|---|---|
| Bark | 34.7 | 24.5 |
| Wood | 63.3 | 29.3 |

1/ Average moisture content of bark was 29 percent of green weight; average moisture content of wood, 54 percent of green weight.

The values just presented are for the run of log sizes in the sample. How much different would they be for larger or smaller logs?

The thickness of bark on pine logs varies directly as the diameter of the log at the point of measurement. This suggests that the proportion of edging or slab volume in bark might also vary with diameter. This possibility was investigated. Tests showed no evidence of such a relationship in the case of edgings. Apparently, the mean bark proportions given for edgings are generally applicable to all sizes of shortleaf pine logs sawed in the same manner and into the same products as the sample logs. However, the proportion of bark in slabs did increase with log diameter (table 3); the regression coefficient proved significant at the 1-percent level.

Table 3.--Proportion of slab volume and green weight in bark, by log diameter

(In percent)

| Log scaling diameter (Inches) | Volume | Green weight |
|---|---|---|
| 5 | 22 | 14 |
| 6 | 24 | 15 |
| 7 | 26 | 16 |
| 8 | 28 | 17 |
| 9 | 30 | 19 |
| 10 | 31 | 20 |
| 11 | 33 | 21 |
| 12 | 35 | 23 |
| 13 | 37 | 24 |
| 14 | 39 | 26 |
| 15 | 40 | 27 |
| 16 | 42 | 29 |
| 17 | 44 | 30 |
| 18 | 46 | 32 |
| 19 | 48 | 33 |

According to unpublished data from the Forest Survey, round pine pulpwood in the Southeast is 78 percent wood and 12 percent bark by volume. The bulk of the wood is delivered in the rough state to the pulp mills, where it is debarked. This means that approximately 7 percent of the annual freight and cartage expense on pulpwood is for the transportation of bark. If the same procedure were applied to sawmill residues, 16 percent of the transportation expenditure on edgings and 21 percent of the transportation expenditure on slabs would be for bark. Pulp companies have presumably found that the greater efficiency and more positive quality control afforded by centralized debarking more than balance any savings that might result from peeling roundwood nearer the source. However, it is doubtful whether this would be true of sawmill residues.

## SIZES, VOLUMES, AND WEIGHTS

Saw logs in the study area are usually cut to 8-, 10-, 12-, 14-, and 16-foot lengths, and they range from 5 to something over 20 inches in diameter. Twelve feet is the most common length, and more lumber is sawed from 8-inch logs than from any other diameter. Since the logs are predominantly small, there is little opportunity to produce short side-lumber. Consequently, slabs and edgings tend

to be nearly the full length of the logs from which they are sawed. This is particularly true of edgings. Fifty-two percent of the sample logs were 12-footers; 52 percent of the edgings were also 12 feet long. A high proportion of the short slabs and edgings in the sample were the result of breakage in offbearing.

More important than lengths from a salvage standpoint are the cross-sectional dimensions of residues. They strongly influence the design and capacities of processing machinery, and volume or weight of usable material per lineal foot is a valuable cost indicator. Table 4 shows the distribution of the sample slabs by thickness and width at their largest points. Since the table values are cumulative, each percent represents the proportion of the total number of slabs that could be passed through an opening of the specified size. For example, an opening 3-1/2 x 9 inches would accommodate 75 percent of the slabs; an opening 4-1/2 x 15 inches would accommodate 99 percent--all of the pieces likely to be usable.

Table 4.--Slabs that do not exceed specified thicknesses and widths

(In percent of total)

| Thickness outside bark (Inches) | Width outside bark: 5 in. | 6 in. | 7 in. | 8 in. | 9 in. | 10 in. | 11 in. | 12 in. | 13 in. | 14 in. | 15 in. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 4 | 6 | 6 | 7 | 7 | 7 | 8 | 9 | 9 | 9 |
| 1-1/2 | 7 | 16 | 21 | 25 | 26 | 26 | 26 | 27 | 28 | 28 | 28 |
| 2 | 8 | 26 | 35 | 44 | 50 | 53 | 53 | 54 | 55 | 55 | 55 |
| 2-1/2 | 9 | 30 | 44 | 57 | 64 | 68 | 69 | 71 | 72 | 72 | 72 |
| 3 | -- | 31 | 48 | 63 | 71 | 78 | 80 | 83 | 86 | 86 | 86 |
| 3-1/2 | -- | -- | 50 | 65 | 75 | 83 | 87 | 89 | 92 | 93 | 94 |
| 4 | -- | -- | -- | 66 | 77 | 85 | 90 | 93 | 95 | 96 | 97 |
| 4-1/2 | -- | -- | -- | -- | -- | -- | -- | 94 | 97 | 98 | 99[1]/ |

1/ Remaining 1 percent are wider than 15 inches but so thin as to have practically no wood content.

Edgings present a much narrower range of cross-sectional dimensions than slabs, since their thicknesses correspond to the thickness of the lumber--usually 1 inch, occasionally 2 inches. They vary only in width, the sample edgings attaining a maximum of 7 inches (table 5).

The sample slabs averaged 0.315 cubic foot or 20.0 pounds (green weight) of wood per piece, the edgings 0.085 cubic foot or 5.4 pounds per piece. The corresponding averages per lineal foot were 0.032 and 2.0 for slabs and 0.008 or 0.5 for edgings. Of course, wood volumes and weights varied considerably by individual pieces, and the range was naturally greater for slabs than for edgings with their one fixed dimension. The distribution of pieces by volume and weight classes is shown in tables 6 and 7.

Table 5.--Proportion of edgings that do not exceed specified widths

| Width outside bark : | Edgings |
|---|---|
| Inches | Percent |
| 1 | 12 |
| 1-1/2 | 32 |
| 2 | 57 |
| 2-1/2 | 70 |
| 3 | 79 |
| 3-1/2 | 85 |
| 4 | 90 |
| 4-1/2 | 93 |
| 5 | 96 |
| 5-1/2 | 98 |
| 6 | 99 |
| 6-1/2 | 99 |
| 7 | 100 |

## EFFECTS OF SORTING

Modern force-feed chippers are capable of producing acceptably uniform chips from short, thin, and irregularly shaped pieces of wood. Consequently, lumbermen who debark their logs find it both practicable and profitable to chip nearly all of the slab and edging material. Such a high degree of utilization is not economic at small sawmills. Their waste wood is not bark-free and may have to be transported to a pulp mill or other concentration point before it is debarked or chipped. For these reasons, some small pieces or even thin, barky sections of larger pieces will not pay their way. Successful salvage may depend on rejecting this material by sorting and perhaps by crosscutting.

Slabs or edgings that do not contain enough wood to justify salvage should be eliminated as near the source as possible, preferably as they come from the saw. The culling could well be done by the sawmill offbearer, who has to handle every bit of the material in any case. Sorting might be on the basis of average thickness and length for slabs, average width and length for edgings. Once cost analyses determined the marginal volumes or weights of wood per piece or per lineal foot for an operation, these volumes or weights could be translated into minimum specifications of average thickness (or width) and length. Tables 8 and 9, based on the sample slabs and edgings, are suitable volume tables for this purpose. Tables 10 and 11 are companion tables of green wood weights. The

Table 6.--Distribution of slabs and edgings by volume of wood

| Volume per piece (Cubic feet) | Slabs | Edgings | Volume per lineal foot (Cubic feet) | Slabs | Edgings |
|---|---|---|---|---|---|
| | Percent | Percent | | Percent | Percent |
| .01-.05 | 2 | 36 | .001-.005 | 2 | 40 |
| .06-.10 | 7 | 32 | .006-.010 | 5 | 38 |
| .11-.15 | 9 | 19 | .011-.015 | 8 | 16 |
| .16-.20 | 11 | 10 | .016-.020 | 11 | 5 |
| .21-.25 | 12 | 2 | .021-.025 | 13 | 1 |
| .26-.30 | 12 | 1 | .026-.030 | 14 | (1/) |
| .31-.35 | 11 | -- | .031-.035 | 12 | (1/) |
| .36-.40 | 10 | -- | .036-.040 | 10 | (1/) |
| .41-.45 | 8 | -- | .041-.045 | 8 | -- |
| .46-.50 | 6 | -- | .046-.050 | 6 | -- |
| .51-.55 | 5 | -- | .051-.055 | 5 | -- |
| .56-.60 | 3 | -- | .056-.060 | 2 | -- |
| .61-.65 | 1 | -- | .061-.065 | 1 | -- |
| .66-.70 | 1 | -- | .066-.070 | 1 | -- |
| .71-.75 | 1 | -- | .071-.075 | 1 | -- |
| .76-.80 | 1 | -- | .076-.080 | 1 | -- |
| | 100 | 100 | | 100 | 100 |

1/ Less than 1/2 of 1 percent.

Table 7.--Distribution of slabs and edgings by green weight of wood

| Weight per piece (Pounds) | Slabs | Edgings | Weight per lineal foot (Pounds) | Slabs | Edgings |
|---|---|---|---|---|---|
| | Percent | Percent | | Percent | Percent |
| 1- 5 | 5 | 56 | .1- .5 | 5 | 63 |
| 6-10 | 14 | 32 | .6-1.0 | 13 | 30 |
| 11-15 | 19 | 10 | 1.1-1.5 | 19 | 5 |
| 16-20 | 20 | 2 | 1.6-2.0 | 22 | 1 |
| 21-25 | 16 | -- | 2.1-2.5 | 17 | 1 |
| 26-30 | 12 | -- | 2.6-3.0 | 11 | -- |
| 31-35 | 8 | -- | 3.1-3.5 | 8 | -- |
| 36-40 | 4 | -- | 3.6-4.0 | 3 | -- |
| 41-45 | 1 | -- | 4.1-4.5 | 1 | -- |
| 46-50 | 1 | -- | 4.6-5.0 | 1 | -- |
| | 100 | 100 | | 100 | 100 |

Table 8.--Wood volume per piece for entire slabs, by average thickness and length

(In cubic feet)

| Average thickness outside bark (Inches) | Length | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 ft.[1/] | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. | 11 ft. | 12 ft. | 13 ft. | 14 ft. | 15 ft. | 16 ft. |
| .5 | .011 | .022 | .033 | .044 | .055 | .066 | .077 | .088 | .099 | .110 | .121 | .132 | .143 | .154 | .165 | .176 |
| .6 | .013 | .026 | .040 | .053 | .066 | .079 | .092 | .106 | .119 | .132 | .145 | .158 | .172 | .185 | .198 | .211 |
| .7 | .015 | .031 | .046 | .062 | .077 | .092 | .108 | .123 | .139 | .154 | .169 | .185 | .200 | .216 | .231 | .246 |
| .8 | .018 | .035 | .053 | .070 | .088 | .106 | .123 | .141 | .158 | .176 | .194 | .211 | .229 | .246 | .264 | .282 |
| .9 | .020 | .040 | .059 | .079 | .099 | .119 | .139 | .158 | .178 | .198 | .218 | .238 | .257 | .277 | .297 | .317 |
| 1.0 | .022 | .044 | .066 | .088 | .110 | .132 | .154 | .176 | .198 | .220 | .242 | .264 | .286 | .308 | .330 | .352 |
| 1.1 | .024 | .048 | .073 | .097 | .121 | .145 | .169 | .194 | .218 | .242 | .266 | .290 | .315 | .339 | .363 | .387 |
| 1.2 | .026 | .053 | .079 | .106 | .132 | .158 | .185 | .211 | .238 | .264 | .290 | .317 | .343 | .370 | .396 | .422 |
| 1.3 | .029 | .057 | .086 | .114 | .143 | .172 | .200 | .229 | .257 | .286 | .315 | .343 | .372 | .400 | .429 | .458 |
| 1.4 | .031 | .062 | .092 | .123 | .154 | .185 | .216 | .246 | .277 | .308 | .339 | .370 | .400 | .431 | .462 | .493 |
| 1.5 | .033 | .066 | .099 | .132 | .165 | .198 | .231 | .264 | .297 | .330 | .363 | .396 | .429 | .462 | .495 | .528 |
| 1.6 | .035 | .070 | .106 | .141 | .176 | .211 | .246 | .282 | .317 | .352 | .387 | .422 | .458 | .493 | .528 | .563 |
| 1.7 | .037 | .075 | .112 | .150 | .187 | .224 | .262 | .299 | .337 | .374 | .411 | .449 | .486 | .524 | .561 | .598 |
| 1.8 | .040 | .079 | .119 | .158 | .198 | .238 | .277 | .317 | .356 | .396 | .436 | .475 | .515 | .554 | .594 | .634 |
| 1.9 | .042 | .084 | .125 | .167 | .209 | .251 | .293 | .334 | .376 | .418 | .460 | .502 | .543 | .585 | .627 | .669 |

1/ Volume per lineal foot.

Table 9.--Wood volume per piece for entire edgings, by average width and length

(In cubic feet)

| Average width outside bark (Inches) | Length | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 ft.[1/] | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. | 11 ft. | 12 ft. | 13 ft. | 14 ft. | 15 ft. | 16 ft. |
| .5 | .003 | .006 | .010 | .013 | .016 | .019 | .022 | .026 | .029 | .032 | .035 | .038 | .042 | .045 | .048 | .051 |
| .6 | .004 | .008 | .011 | .015 | .019 | .023 | .027 | .030 | .034 | .038 | .042 | .046 | .049 | .053 | .057 | .061 |
| .7 | .004 | .009 | .013 | .018 | .022 | .026 | .031 | .035 | .040 | .044 | .048 | .053 | .057 | .062 | .066 | .070 |
| .8 | .005 | .010 | .015 | .020 | .026 | .031 | .036 | .041 | .046 | .051 | .056 | .061 | .066 | .071 | .076 | .082 |
| .9 | .006 | .011 | .017 | .023 | .028 | .034 | .040 | .046 | .051 | .057 | .063 | .068 | .074 | .080 | .086 | .091 |
| 1.0 | .006 | .013 | .019 | .025 | .032 | .038 | .044 | .050 | .057 | .063 | .069 | .076 | .082 | .088 | .094 | .101 |
| 1.1 | .007 | .014 | .021 | .028 | .035 | .042 | .049 | .056 | .063 | .070 | .077 | .084 | .091 | .098 | .105 | .112 |
| 1.2 | .008 | .015 | .023 | .030 | .038 | .046 | .053 | .061 | .068 | .076 | .084 | .091 | .099 | .106 | .114 | .122 |
| 1.3 | .008 | .016 | .025 | .033 | .041 | .049 | .057 | .066 | .074 | .082 | .090 | .098 | .107 | .115 | .123 | .131 |
| 1.4 | .009 | .018 | .027 | .036 | .044 | .053 | .062 | .071 | .080 | .089 | .098 | .107 | .116 | .125 | .134 | .142 |
| 1.5 | .010 | .019 | .028 | .038 | .048 | .057 | .066 | .076 | .086 | .095 | .104 | .114 | .124 | .133 | .142 | .152 |
| 1.6 | .010 | .020 | .030 | .040 | .050 | .061 | .071 | .081 | .091 | .101 | .111 | .121 | .131 | .141 | .152 | .162 |
| 1.7 | .011 | .022 | .032 | .043 | .054 | .065 | .076 | .086 | .097 | .108 | .119 | .130 | .140 | .151 | .162 | .173 |
| 1.8 | .011 | .023 | .034 | .046 | .057 | .068 | .080 | .091 | .103 | .114 | .125 | .137 | .148 | .160 | .171 | .182 |
| 1.9 | .012 | .024 | .036 | .048 | .060 | .072 | .084 | .096 | .108 | .120 | .132 | .144 | .156 | .168 | .180 | .192 |
| 2.0 | .013 | .025 | .038 | .051 | .064 | .076 | .089 | .102 | .114 | .127 | .140 | .152 | .165 | .178 | .190 | .203 |
| 2.1 | .013 | .027 | .040 | .053 | .066 | .080 | .093 | .106 | .120 | .133 | .146 | .160 | .173 | .186 | .200 | .213 |
| 2.2 | .014 | .028 | .042 | .056 | .070 | .083 | .097 | .111 | .125 | .139 | .153 | .167 | .181 | .195 | .208 | .222 |
| 2.3 | .014 | .029 | .044 | .058 | .072 | .087 | .102 | .116 | .130 | .145 | .160 | .174 | .188 | .203 | .218 | .232 |
| 2.4 | .015 | .030 | .046 | .061 | .076 | .091 | .106 | .122 | .137 | .152 | .167 | .182 | .198 | .213 | .228 | .243 |

1/ Volume per lineal foot.

corresponding oven-dry weights can be calculated using the ratio 0.46 pound oven-dry per pound green. Tables 12 through 15 show how much of the potentially chippable wood in the samples met various specifications as to size. The proportions in tables 14 and 15 apply to volumes or weights alike.

Rejecting the smaller slabs and edgings would reduce salvage costs by increasing the yield of wood chips per piece or per lineal foot handled. Eliminating thin pieces should further lower costs by reducing the quantity of bark that had to be transported and peeled to obtain a given quantity of bark-free wood. For example, the sample slabs averaged 21 percent bark by weight. Tests indicated that if the thinnest pieces were progressively eliminated each resulting increase of 1/10-inch in average slab thickness would reduce the proportion of bark 1 percent. To put it differently, each 1/10-inch increase in average thickness would mean a saving of roughly 5 percent in the cost of transporting the rough slabs and somewhat smaller savings in other phases of the salvage process.

## EFFECTS OF CROSSCUTTING

Slabs or edgings as they come from the saw are in a variety of lengths ranging from 2 to 16 feet. Crosscutting them to standard lengths would facilitate package transportation and the use of cranes or fork lift trucks at destination. Also, thin barky sections could be removed to up the yield of wood per lineal foot of rough material. Tables 16 through 21 show the effects (calculated from sectional measurements) of crosscutting the sample slabs to various minimum thicknesses and standard lengths, the sample edgings to various minimum widths and standard lengths. Tables 16 and 17 compare the resulting numbers of pieces with the original numbers of slabs and edgings; tables 18 and 19 compare the resulting volumes or weights of wood with the total original volumes or weights, and tables 20 and 21 compare the volumes and weights per lineal foot. Although the last-named tables were based on crosscutting to 4-foot lengths, the values for 5-, 6-, or 8-foot lengths were not appreciably different.

Merely crosscutting slabs to a standard length without setting any minimum thickness has the effect of raising the volume (and weight) of wood per lineal foot. The amount of wood per lineal foot can be further increased by adopting a minimum thickness as well. In the case of edgings, however, cutting to standard lengths produces no such gain; wood volume can be increased only by adopting a minimum width.

Crosscutting increases not only the absolute volume (and weight) of wood per lineal foot but also the ratio of wood to bark. The proportion of wood in both the sample slabs and edgings was

raised 1 to 2 percent by cutting to standard lengths alone. Further rises of 1/2 to 1 percent accompanied each increase of 1/2-inch in the minimum thickness of slabs or the minimum width of edgings. The latter gain was more pronounced for edgings than for slabs. It was also greater when the residues were cut to the shorter lengths (4 or 5 feet). As a matter of fact, the proportion of wood in 8-foot lengths was increased none at all by the adoption of a thickness or width standard, and actually decreased when the minimum thickness or width was greater than 1 inch.

The principal disadvantages of crosscutting are the added cost of the operation itself and the fact that more pieces must be handled to obtain a given quantity of salvage material. The second objection can be partially overcome by the use of pallets, straps, or other package-loading devices.

## WEIGHT AS A BASIS FOR MEASUREMENT

Stacked volume is the traditional measure of pulpwood in the South. At present, both the standard cord of 128 cubic feet and the "unit" of 160 or 168 cubic feet are in use. However, stacked volume is at best a rather crude measure of actual wood volume and an even poorer measure of the cellulose content which largely determines pulping value. Furthermore, the accurate scaling of cordwood on trucks or railroad cars is a time-consuming task. For these reasons, at least three paper companies are now purchasing wood by weight.

Stacked volume is an even less efficient measure of sawmill slabs and edgings than of roundwood. The greater number of pieces per cord and the greater variety of sizes and shapes result in wider variation in air space. There is also the fact that the solid component contains two to three times as much bark as with roundwood. When it becomes necessary to relate yields of bark-free chips to quantities of rough material, a further complication is introduced.

West Coast procedure is to measure residues in cords. When a cord of residues is chipped, the result is termed a "unit" of chips (not to be confused with a unit of southern pulpwood). The space occupied by a unit of chips ranges from 210 to 291 cubic feet.2/ Combining this variation with that of air and bark volumes in the original piled residues compounds the confusion.

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2/ Fobes, E. W. Status of portable wood chippers. Forest Products Research Society Preprint, 1949.

Table 10.--Green wood weights per piece for entire slabs, by average thickness and length

(In pounds)

| Average thickness outside bark (Inches) | Length | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 ft.[1/] | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. | 11 ft. | 12 ft. | 13 ft. | 14 ft. | 15 ft. | 16 ft. |
| .5 | .7 | 1.4 | 2.1 | 2.8 | 3.5 | 4.2 | 4.9 | 5.6 | 6.3 | 7.0 | 7.7 | 8.4 | 9.1 | 9.7 | 10.4 | 11.1 |
| .6 | .8 | 1.7 | 2.5 | 3.3 | 4.2 | 5.0 | 5.8 | 6.7 | 7.5 | 8.4 | 9.2 | 10.0 | 10.9 | 11.7 | 12.5 | 13.4 |
| .7 | 1.0 | 1.9 | 2.9 | 3.9 | 4.9 | 5.8 | 6.8 | 7.8 | 8.8 | 9.7 | 10.7 | 11.7 | 12.7 | 13.6 | 14.6 | 15.6 |
| .8 | 1.1 | 2.2 | 3.3 | 4.5 | 5.6 | 6.7 | 7.8 | 8.9 | 10.0 | 11.1 | 12.3 | 13.4 | 14.5 | 15.6 | 16.7 | 17.8 |
| .9 | 1.3 | 2.5 | 3.8 | 5.0 | 6.3 | 7.5 | 8.8 | 10.0 | 11.3 | 12.5 | 13.8 | 15.0 | 16.3 | 17.5 | 18.8 | 20.1 |
| 1.0 | 1.4 | 2.8 | 4.2 | 5.6 | 7.0 | 8.4 | 9.7 | 11.1 | 12.5 | 13.9 | 15.3 | 16.7 | 18.1 | 19.5 | 20.9 | 22.3 |
| 1.1 | 1.5 | 3.1 | 4.6 | 6.1 | 7.7 | 9.2 | 10.7 | 12.3 | 13.8 | 15.3 | 16.9 | 18.4 | 19.9 | 21.4 | 23.0 | 24.5 |
| 1.2 | 1.7 | 3.3 | 5.0 | 6.7 | 8.4 | 10.0 | 11.7 | 13.4 | 15.0 | 16.7 | 18.3 | 20.1 | 21.7 | 23.4 | 25.1 | 26.7 |
| 1.3 | 1.8 | 3.6 | 5.4 | 7.2 | 9.1 | 10.9 | 12.7 | 14.5 | 16.3 | 18.1 | 19.9 | 21.7 | 23.5 | 25.3 | 27.2 | 29.0 |
| 1.4 | 1.9 | 3.9 | 5.8 | 7.8 | 9.7 | 11.7 | 13.6 | 15.6 | 17.5 | 19.5 | 21.4 | 23.4 | 25.3 | 27.3 | 29.2 | 31.2 |
| 1.5 | 2.1 | 4.2 | 6.3 | 8.4 | 10.4 | 12.5 | 14.6 | 16.7 | 18.8 | 20.9 | 23.0 | 25.1 | 27.2 | 29.2 | 31.3 | 33.4 |
| 1.6 | 2.2 | 4.5 | 6.7 | 8.9 | 11.1 | 13.4 | 15.6 | 17.8 | 20.1 | 22.3 | 24.5 | 26.7 | 29.0 | 31.2 | 33.4 | 35.7 |
| 1.7 | 2.4 | 4.7 | 7.1 | 9.5 | 11.8 | 14.2 | 16.6 | 18.9 | 21.3 | 23.7 | 26.0 | 28.4 | 30.8 | 33.1 | 35.5 | 37.9 |
| 1.8 | 2.5 | 5.0 | 7.5 | 10.0 | 12.5 | 15.0 | 17.5 | 20.1 | 22.6 | 25.1 | 27.6 | 30.1 | 32.6 | 35.1 | 37.6 | 40.1 |
| 1.9 | 2.6 | 5.3 | 7.9 | 10.6 | 13.2 | 15.9 | 18.5 | 21.2 | 23.8 | 26.5 | 29.1 | 31.8 | 34.4 | 37.0 | 39.7 | 42.3 |

1/ Weight per lineal foot.

Table 11.--Green wood weights per piece for entire edgings, by average width and length

(In pounds)

| Average width outside bark (Inches) | Length | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 ft.[1/] | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. | 11 ft. | 12 ft. | 13 ft. | 14 ft. | 15 ft. | 16 ft. |
| .5 | .2 | .4 | .6 | .8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 |
| .6 | .2 | .5 | .7 | 1.0 | 1.2 | 1.4 | 1.7 | 1.9 | 2.2 | 2.4 | 2.6 | 2.9 | 3.1 | 3.4 | 3.6 | 3.8 |
| .7 | .3 | .6 | .8 | 1.1 | 1.4 | 1.7 | 1.9 | 2.2 | 2.5 | 2.8 | 3.1 | 3.3 | 3.6 | 3.9 | 4.2 | 4.5 |
| .8 | .3 | .6 | 1.0 | 1.3 | 1.6 | 1.9 | 2.3 | 2.6 | 2.9 | 3.2 | 3.6 | 3.9 | 4.2 | 4.5 | 4.8 | 5.2 |
| .9 | .4 | .7 | 1.1 | 1.4 | 1.8 | 2.2 | 2.5 | 2.9 | 3.2 | 3.6 | 4.0 | 4.3 | 4.7 | 5.1 | 5.4 | 5.8 |
| 1.0 | .4 | .8 | 1.2 | 1.6 | 2.0 | 2.4 | 2.8 | 3.2 | 3.6 | 4.0 | 4.4 | 4.8 | 5.2 | 5.6 | 6.0 | 6.4 |
| 1.1 | .4 | .9 | 1.3 | 1.8 | 2.2 | 2.7 | 3.1 | 3.5 | 4.0 | 4.4 | 4.9 | 5.3 | 5.8 | 6.2 | 6.6 | 7.1 |
| 1.2 | .5 | 1.0 | 1.4 | 1.9 | 2.4 | 2.9 | 3.4 | 3.8 | 4.3 | 4.8 | 5.3 | 5.8 | 6.3 | 6.7 | 7.2 | 7.7 |
| 1.3 | .5 | 1.0 | 1.6 | 2.1 | 2.6 | 3.1 | 3.6 | 4.2 | 4.7 | 5.2 | 5.7 | 6.2 | 6.7 | 7.3 | 7.8 | 8.3 |
| 1.4 | .6 | 1.1 | 1.7 | 2.3 | 2.8 | 3.4 | 3.9 | 4.5 | 5.1 | 5.6 | 6.2 | 6.8 | 7.3 | 7.9 | 8.4 | 9.0 |
| 1.5 | .6 | 1.2 | 1.8 | 2.4 | 3.0 | 3.6 | 4.2 | 4.8 | 5.4 | 6.0 | 6.6 | 7.2 | 7.8 | 8.4 | 9.0 | 9.6 |
| 1.6 | .6 | 1.3 | 1.9 | 2.6 | 3.2 | 3.8 | 4.5 | 5.1 | 5.8 | 6.4 | 7.0 | 7.7 | 8.3 | 9.0 | 9.6 | 10.2 |
| 1.7 | .7 | 1.4 | 2.1 | 2.7 | 3.4 | 4.1 | 4.8 | 5.5 | 6.2 | 6.8 | 7.5 | 8.2 | 8.9 | 9.6 | 10.3 | 10.9 |
| 1.8 | .7 | 1.4 | 2.2 | 2.9 | 3.6 | 4.3 | 5.1 | 5.8 | 6.5 | 7.2 | 7.9 | 8.7 | 9.4 | 10.1 | 10.8 | 11.5 |
| 1.9 | .8 | 1.5 | 2.3 | 3.0 | 3.8 | 4.6 | 5.3 | 6.1 | 6.8 | 7.6 | 8.4 | 9.1 | 9.9 | 10.6 | 11.4 | 12.2 |
| 2.0 | .8 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 5.6 | 6.4 | 7.2 | 8.0 | 8.8 | 9.6 | 10.5 | 11.3 | 12.1 | 12.9 |
| 2.1 | .8 | 1.7 | 2.5 | 3.4 | 4.2 | 5.1 | 5.9 | 6.7 | 7.6 | 8.4 | 9.3 | 10.1 | 10.9 | 11.8 | 12.6 | 13.5 |
| 2.2 | .9 | 1.8 | 2.6 | 3.5 | 4.4 | 5.3 | 6.2 | 7.0 | 7.9 | 8.8 | 9.7 | 10.6 | 11.4 | 12.3 | 13.2 | 14.1 |
| 2.3 | .9 | 1.8 | 2.8 | 3.7 | 4.6 | 5.5 | 6.4 | 7.3 | 8.3 | 9.2 | 10.1 | 11.0 | 11.9 | 12.9 | 13.8 | 14.7 |
| 2.4 | 1.0 | 1.9 | 2.9 | 3.8 | 4.8 | 5.8 | 6.7 | 7.7 | 8.7 | 9.6 | 10.6 | 11.5 | 12.5 | 13.5 | 14.4 | 15.4 |

1/ Weight per lineal foot.

Much of the confusion might be avoided at the start of salvage operations in this region by adopting weight as standard measure at all stages, from rough residues to chips and on to the final pulp. Small-scale tests conducted during the course of this study indicated that tonnage yields of bark-free, green or oven-dry wood per ton of slabs or edgings with bark were relatively stable from one batch to another and from one sawmill to another over extensive areas. Needless to say, if gross weight is accurately convertible to bark-free, oven-dry weight, it can also be converted accurately to terms of expected pulp yields.

The residue samples gave the following converting factors:

For slabs--

1,570 pounds green wood per ton of green, unbarked material, or

728 pounds oven-dry wood per ton of green, unbarked material.

For edgings--

1,674 pounds green wood per ton of green, unbarked material, or

776 pounds oven-dry wood per ton of green, unbarked material.

These factors did not vary significantly by sawmills and only slightly with the diameter of the logs sawed. The 6-1/2-percent greater yield of wood from edgings was found to be significant at the 1-percent level.

If truckloads of rough, green slabs or edgings were weighed, application of the factors would give the net weights of bark-free wood, green or oven-dry, with an error of less than 3 percent (two standard errors). To convert the net weights to expected yields of usable chips, one need only make a proper deduction for slivers, fines, and other screenings. Conversions of this accuracy are impossible with volume measurements, and a truck can be weighed in a fraction of the time required to scale its load.

The converting factors given above are for freshly sawn shortleaf pine. They do not apply to species with thicker or thinner bark or to dry material. However, it would not be difficult to prepare similar factors for other species or even combinations of species, and adjustments for varying moisture contents can be made if desired. In this connection, it is interesting to note that pulp mills which purchase roundwood by weight make much of the fact that their wood is fresher than the wood received at mills that do not. Presumably, the same advantage would accrue to those who purchased slabs or edgings on a weight basis.

Table 12.--Slabs larger than specified average thicknesses and lengths

(In percent of total)

| Average thickness outside bark (Inches) | Length | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. | 11 ft. | 12 ft. | 13 ft. | 14 ft. | 15 ft. | 16 ft. |
| 1/2 | 1/100 | 99 | 96 | 91 | 86 | 75 | 71 | 63 | 58 | 50 | 46 | 27 | 26 | 10 | 2 |
| 1 | 85 | 85 | 82 | 79 | 76 | 69 | 66 | 58 | 55 | 47 | 44 | 25 | 24 | 9 | 2 |
| 1-1/2 | 31 | 31 | 31 | 30 | 28 | 26 | 25 | 23 | 22 | 18 | 17 | 12 | 12 | 5 | 1 |
| 2 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | (2/) |

1/ There were no pieces less than 1/2 inch thick.

2/ Less than 1/2 of 1 percent.

Table 13.--Edgings larger than specified average widths and lengths

(In percent of total)

| Average width outside bark (Inches) | Length | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. | 11 ft. | 12 ft. | 13 ft. | 14 ft. | 15 ft. | 16 ft. |
| 1/2 | 1/100 | 98 | 96 | 93 | 91 | 88 | 88 | 80 | 76 | 70 | 66 | 14 | 13 | 8 | 4 |
| 1 | 87 | 86 | 85 | 82 | 81 | 79 | 79 | 73 | 71 | 66 | 62 | 12 | 12 | 7 | 3 |
| 1-1/2 | 47 | 46 | 45 | 44 | 44 | 43 | 43 | 41 | 41 | 40 | 39 | 4 | 3 | 2 | 1 |
| 2 | 20 | 20 | 20 | 19 | 19 | 19 | 19 | 18 | 18 | 18 | 18 | (2/) | (2/) | (2/) | (2/) |
| 2-1/2 | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 8 | (2/) | (2/) | (2/) | (2/) |

1/ There were no pieces less than 1/2 inch wide.

2/ Less than 1/2 of 1 percent.

Table 14.--Volume or weight of wood in slabs larger than specified average thicknesses and lengths

(In percent of total)

| Average thickness outside bark (Inches) | Length | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. | 11 ft. | 12 ft. | 13 ft. | 14 ft. | 15 ft. | 16 ft. |
| 1/2 | 1/ 100 | 100 | 99 | 97 | 94 | 88 | 86 | 78 | 74 | 65 | 62 | 38 | 38 | 16 | 3 |
| 1 | 96 | 96 | 95 | 93 | 90 | 85 | 83 | 75 | 72 | 63 | 60 | 37 | 36 | 15 | 3 |
| 1-1/2 | 46 | 46 | 46 | 45 | 43 | 41 | 40 | 36 | 35 | 30 | 29 | 21 | 21 | 10 | 2 |
| 2 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 5 | 5 | 3 | 3 | 3 | 3 | 2 | (2/) |

1/ There were no pieces less than 1/2 inch thick.

2/ Less than 1/2 of 1 percent.

Table 15.--Volume or weight of wood in edgings larger than specified average widths and lengths

(In percent of total)

| Average width outside bark (Inches) | Length | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. | 11 ft. | 12 ft. | 13 ft. | 14 ft. | 15 ft. | 16 ft. |
| 1/2 | 1/ 100 | 100 | 99 | 98 | 97 | 96 | 96 | 91 | 90 | 86 | 83 | 15 | 14 | 9 | 4 |
| 1 | 96 | 96 | 95 | 94 | 94 | 93 | 92 | 88 | 87 | 83 | 80 | 14 | 13 | 8 | 4 |
| 1-1/2 | 67 | 67 | 66 | 66 | 65 | 65 | 64 | 62 | 62 | 61 | 60 | 5 | 5 | 2 | 1 |
| 2 | 37 | 37 | 37 | 36 | 36 | 36 | 35 | 35 | 35 | 35 | 35 | 1 | 1 | (2/) | (2/) |
| 2-1/2 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | (2/) | (2/) | (2/) | (2/) |

1/ There were no pieces less than 1/2 inch wide.

2/ Less than 1/2 of 1 percent.

Table 16.--Pieces obtained from crosscutting 100 slabs to specified minimum thicknesses and standard lengths

(In numbers)

| Minimum thickness outside bark (Inches) | Length | | | | |
|---|---|---|---|---|---|
| | All lengths | 4 feet | 5 feet | 6 feet | 8 feet |
| No minimum | 100 | 219 | 158 | 137 | 75 |
| 1/2 | 100 | 197 | 142 | 116 | 68 |
| 1 | 101 | 139 | 99 | 75 | 44 |
| 1-1/2 | 82 | 59 | 35 | 24 | 11 |
| 2 | 42 | 10 | 5 | 3 | 1 |

Table 17.--Pieces obtained from crosscutting 100 edgings to specified minimum widths and standard lengths

(In numbers)

| Minimum width outside bark (Inches) | Length | | | | |
|---|---|---|---|---|---|
| | All lengths | 4 feet | 5 feet | 6 feet | 8 feet |
| No minimum | 100 | 252 | 178 | 154 | 95 |
| 1/2 | 106 | 189 | 135 | 113 | 68 |
| 1 | 99 | 107 | 68 | 54 | 32 |
| 1-1/2 | 61 | 50 | 32 | 25 | 11 |
| 2 | 37 | 21 | 16 | 9 | 4 |

Table 18.--Wood volume or weight remaining after crosscutting slabs to specified minimum thicknesses and standard lengths

(In percent of total)

| Minimum thickness outside bark (Inches) | Length | | | | |
|---|---|---|---|---|---|
| | All lengths | 4 feet | 5 feet | 6 feet | 8 feet |
| No minimum | 100 | 94 | 88 | 88 | 68 |
| 1/2 | 99 | 89 | 81 | 77 | 64 |
| 1 | 91 | 74 | 67 | 58 | 47 |
| 1-1/2 | 64 | 42 | 31 | 24 | 14 |
| 2 | 30 | 10 | 7 | 3 | 1 |

Table 19.--Wood volume or weight remaining after crosscutting edgings to specified minimum widths and standard lengths

(In percent of total)

| Minimum width outside bark (Inches) | Length | | | | |
|---|---|---|---|---|---|
| | All lengths | 4 feet | 5 feet | 6 feet | 8 feet |
| No minimum | 100 | 97 | 89 | 93 | 76 |
| 1/2 | 96 | 87 | 79 | 81 | 66 |
| 1 | 78 | 64 | 55 | 51 | 40 |
| 1-1/2 | 53 | 39 | 32 | 30 | 19 |
| 2 | 34 | 21 | 20 | 14 | 7 |

Table 20.--Volumes and green weights of wood per lineal foot of slabs crosscut to 4-foot lengths and to specified minimum thicknesses

| Minimum thickness outside bark (Inches) | Volume | Green weight |
|---|---|---|
| | Cubic feet | Pounds |
| No minimum | .034 | 2.2 |
| 1/2 | .036 | 2.3 |
| 1 | .043 | 2.7 |
| 1-1/2 | .057 | 3.6 |
| 2 | .075 | 4.7 |
| No crosscutting | .032 | 2.0 |

Table 21.--Volumes and green weights of wood per lineal foot of edgings crosscut to 4-foot lengths and to specified minimum widths

| Minimum width outside bark (Inches) | Volume | Green weight |
|---|---|---|
| | Cubic feet | Pounds |
| No minimum | .008 | .5 |
| 1/2 | .008 | .5 |
| 1 | .011 | .7 |
| 1-1/2 | .014 | .9 |
| 2 | .018 | 1.1 |
| No crosscutting | .008 | .5 |